Evaluation of Tunnel ConditionsCentral Oregon and Pacific Railroad, Coos Bay Subdivision

On Wednesday, October 9, 2007, a reconnaissance was conducted by a team of Federal Railroad Administration (FRA) and Federal Highway Administration engineers to observe conditions in Tunnels 13, 15, and 18 on the Coos Bay Subdivision of the Central Oregon and Pacific Railroad (CORP). Tunnels 13, 15, and 18 had been removed from service by CORP, and the Coos Bay Subdivision, south of Tunnel 13, is currently embargoed for all traffic.

The reconnaissance was conducted by walking through each tunnel from portal to portal, with illumination provided by flood lights mounted in the bed of a highway-rail truck and powered by a portable generator. Conditions observed in the tunnels were compared to the condition descriptors and general condition ratings contained in the report prepared by Shannon and Wilson between March 30 and July 9, 2007, and furnished to FRA by CORP.

The team evaluation substantially validates the findings documented in the Shannon and Wilson report. It should be noted that some conditions have deteriorated even further during the time since the report was prepared, partly due to the passage of time, and partly because of the onset of the wet season in Oregon in the early fall of 2007.

These tunnels were generally built in the 1880's, and rebuilt to their present configuration around 1914, using drill and blast methods common in that era. Tunnel lining construction includes unlined "bald" rock, timber sets with timber lagging, steel sets with timber lagging, shotcrete over timber or steel sets, and finally, cast-in-place concrete at both portals of Tunnels 13 and 15, and the south portal of Tunnel 18.

Timber sets are constructed of 10" wide by 14" deep solid sawn cedar timbers.

These sets are spaced on 48" nominal centers in Tunnels 13 and 18, and on 18" nominal centers in Tunnel 15.

Voids between the timber liner and the surrounding rock were filled with cordwood packing.

The predominant problems observed were decay of the untreated cedar timbers, lagging, and

footing blocks, especially in the wetter areas of the tunnels. This deterioration has resulted in differential settlement of the timber sets leading to shifting and occasional loss of the horizontal struts between adjacent sets. In addition, the lower 3-4 feet of many of the timber set posts sounds hollow or decayed when struck with a hammer, especially in locations where the footing blocks are clearly decayed or

crushing. In a few of the wetter areas, severe decay of the caps and rafter timbers has destroyed the structural integrity of the lining sets. Decay, and subsequent loss of the cordwood packing, has produced a void above or behind the lagging, thereby providing weathering or blocking rock room to free-fall, striking the lagging.

In areas where the timber sets and lagging have been covered with a nonstructural shotcrete veneer, evaluation of the existing condition is not possible, although it is suspected that trapped moisture is probably exacerbating the decay of surrounding timber components.

In the unlined sections, there is evidence that minor, periodic rock-falls have occurred.

General Tunnel Observations

The tunnel bores all appear to have been blasted using the methods of the day, which was to angle drill from the front face and blast. It is doubtful that any type of technique was used to control blast pressures and limit overbreak. Even with modern controlled blasting techniques, drilling and shooting tunnel bores results in some undesirable over- break.

The overbreak on the three tunnels has resulted in an oversized bore with irregular pockets and voids.

Overbreak from blasting has fractured some of the in-place rock.

Thus, the fractured rock has to be supported, or it will continually ravel and fall out.

Several areas in these tunnels had cordwood or stone packing as an effort to support the tunnel ceilings and walls.

The overbroken voids are particularly difficult to support using these methods.

All of the tunnels utilized some arch segmental timber sets and lagging for support. The timber set internal dimensions are approximately 20 feet to the spring line and approximately 10 feet to the crown.

Many of the timber set posts are 10 x 14-inch settings on wood blocks.

The blocks appear to be cut from the post material and then laid on their side.

The original timber set configuration had no structural capability for carrying lateral earth pressure loads from the tunnel walls.

The lagging appears to be rough-cut 2 x 10-inch lumber, but it was not measured during the reconnaissance so these dimensions may not be accurate.

All tunnels have intermittent water seepage areas.

Detailed observations and conclusions for each of the three tunnels are as follows:

Tunnel 13; Milepost (MP) 669.47 to MP 669.94; length 2,489 feet; near Mapleton, Oregon.

The portal had a concrete lining that was dated 1914 and extended approximately 65 feet back. In several locations, there are signs of overblasting and large voids in between the timber lagging. Cordwood packing is visible in between the timber lagging and the tunnel rock wall and ceiling face.

There are intermittent water seepage areas in

this tunnel.

Differential weathering was noted in the tunnel walls.

There are areas that
have rock debris lying on top of the timber sets.

In several locations, rock debris can fall
through, or past, rotten timber.

The timber set support blocks have rotted in several

locations, allowing the timber sets to settle and pull away from the ceiling. In turn, the unsupported ceiling sections have released sandstone rock fragments ranging from gravel- to bolder-size (2 to 14 inches in diameter).

Sagging timber sets have also
kicked out from the tunnel walls, allowing sandstone rock fragments from gravel- to bolder-size to fall out of the excavated walls and place a thrust load on the timber set and lagging.

The tunnel had station markings on the walls from Station 0+00 to 3+00. Shotcrete had been placed, apparently as a past repair.

The shotcrete condition looked good.

At Station 6+00, a vertical set post is cracked from the footing up (at least 3 feet).

This appeared to be an overstress condition.

There is a void behind the timber set.

From Station 14+00 to 16+00, approximately, the timber sets in the ceiling are bowed downward, apparently from overstress.

The timber set ceiling support is discontinuous, and there is evidence that rock blocks have dropped out of the ceiling.

At Station 23+40, timber sets have rotted and fallen down.

There is rock debris perched on top of the timber sets, and it is a rock-fall hazard.

The Shannon and Wilson report rate this area as a Repair Level 2, but subsequent deterioration would most likely cause it to be downgraded to Repair Level 1.

This tunnel has several locations that need immediate lining support repairs.

There is a high risk of tunnel support failure and rock-fall hazard to train and maintenance traffic.

Tunnel 15; length 2,148 feet; near Florence, Oregon.

The north portal had a concrete lining that was dated 1914 and extended approximately 40 feet back. In general, the sandstone rock was softer than that of Tunnel 13. The tunnel has more seepage water, also.

The rock in this area may have been slightly weakened by water saturation.

This tunnel has extensive wood rot and questionable tunnel-wall and ceiling support.

Several repairs have been performed, including installation of a concrete footing for timber set support.

There are signs of overblasting star bursts in the tunnel walls and voids between the timber lagging and the rock face.

There is potential for fractured rock to fall from these voids.

At Station 14+40, the timber sets are very rotten and have sagged.

There is approximately ¾ of a yard of rock debris perched on the rotten wood.

This material will fall down from the ceiling in the very near future.

There is a high concern that rotten timber sets and lagging could fall into tunnel.

There is a high risk of tunnel support failure and some risk of rock-fall hazard to train and maintenance traffic.

Tunnel 18; MP 734.48 to MP 734.77; length 1,532 feet; near Florence, Oregon, off of Five Mile Creek Road.

The north portal had a concrete lining that was dated 1914 and extended approximately 5 feet back. Some past shotcreting and steel sets have been installed in this tunnel. In some areas, the timber sets are closely spaced, indicating that during the original design and construction weak sandstone rock was recognized.

The rock in this tunnel is the weakest of the three.

The joints appear to be tighter, but the rock exhibits more of a soil character and may tend to slough.

There are locations where the lagging has fallen out and the rock face is exposed.

At Station 10+80, there is a section of the timber sets where they have apparently rotted at their bases and then slid off their footings.

The timber sets have then kicked out approximately 2 feet from their original position.

The weak sandstone needs good ceiling and sidewall support, as the tunnel bore faces have weathered over the years and may be exerting more vertical and lateral pressures than where originally anticipated. At the same time, the strength of the timber sets has diminished over the years. The fact that a section of the timber sets has kicked out supports these concerns. More timber sets could kick out, which is a definite hazard to train and maintenance traffic.

Summary and Conclusions

The arch segmental timber sets and lagging in these tunnels have reached the end of their useful life and can no longer provide adequate support. As a result, several locations within each of the three tunnels have unsafe conditions that require repair.

It is anticipated that more unsafe conditions will develop in the near future as the tunnel support continues to rot.

The existing unsafe conditions include ceiling and wall rock- fall, rock debris fall, timber set and lagging instability, and vertical timber set kick out.

These tunnels are hazardous to train traffic and maintenance operations.

Any future inspection or maintenance should be done with great care, with an understanding of the potential hazards.

The original timber set design has severe limitations in its ability to resist lateral earth and rock loads.

In addition, the timber sets are susceptible to fire.

The team evaluation substantially validates the findings documented in the Shannon and Wilson report. It should be noted that some conditions have deteriorated even further during the time since the report was prepared, partly due to the passage of time, and partly because of the onset of the wet season in Oregon in the early fall of 2007.

In summary, FRA concurs with the recommendations made in the Shannon and Wilson report, that all three tunnels need immediate repairs to permit the safe resumption of railroad operations.

The reconnaissance was not intended to review all of the repair recommendations that were made in the Shannon and Wilson report.

All tunnel dimensions provided in this memorandum are approximate and should not be used for design or cost estimating.

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